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four circular outlines of muscular tissue, which are also broken in their continuity by fatty tissue and degenerating muscular fibers. The change, therefore, is effected by the fatty degeneration of the fleshy fibers of the muscles and the coincident increase of the connective tissue elements. It is an instance of a pathological process bringing about a morphological change.

The examination of these ligaments in their embryonic condition affords some interesting results. It shows that the amount of muscular tissue in their midst is proportionately greater than in the adult, and further, that so long as the embryo is *in utero* there is not the slightest tendency to fatty degeneration exhibited in this fleshy tissue. After birth, however, when the foot is called into play, and its requirements show a greater need in the suspensory ligament of fibrous than muscular tissue the change begins. The active change is thus confined entirely to the extra uterine life of the animal, but a condition is produced in the parent which affects the offspring. It is an admirable instance of the slow progress made by morphological changes and how processes of this nature are thrown back a stage in the embryo. Provided that the external circumstances which originally instituted the change remain unaltered, we may consider that there are two conditions at work, *conservative* in the embryo, *progressive* in the adult; but the latter has the advantage, inasmuch as it is aided by the influence of heredity. From this, therefore, we may argue that in the course of time the transformation of the suspensory ligament will become complete, and that ultimately not a trace of muscular tissue will appear in its midst. It is very evident, however, that the fleshy fibers will be longer of disappearing in the fœtus than in the adult.

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THE WINOOSKI OR WAKEFIELD MARBLE OF VERMONT.

BY PROFESSOR GEO. H. PERKINS.

BEDS of primordial rock known as "the red sandrock" extend through Western Vermont from the northern limit of the State south into Shoreham where the formation disappears. Its breadth is nowhere very great, and it is chiefly confined to the immediate neighborhood of Lake Champlain. Here and there on the lake shore are bold headlands composed of this rock.

Most commonly it is a hard, dark red sandstone containing, besides a large percentage of silica, eight or nine per cent of potash, about the same of iron, and more or less of lime. The composition of the rock is not uniform, but differs greatly in different portions even of the same stratum.

The color, though chiefly dark red, is sometimes light red or even reddish-buff. Moreover the entire formation, which is about two thousand feet thick, includes limestones, dolomites, slates and shales, though the red sandrock is, in most places, by far the most conspicuous member of the formation, and forms the greater part of its thickness. Still, in some localities other beds make up a not inconsiderable portion of the whole, as the following section taken at Swanton by Sir William Logan, and given here with some modification, shows:

	Feet.
1. White and red dolomites (Winooski marble) with sandy layers;—some of the strata are mottled, rose red and white, and a few are brick red or Indian red. Some of the red beds contain *Conocephalites adamsi* and *C. vulcanus*	370
2. Gray argillaceous limestone, partially magnesian, holding a great abundance of *Palæophycus incipiens*	110
3. Buff sandy dolomite	40
4. Dark gray and bluish-black slate, partially magnesian, with thin bands of sandy dolomite. The slate contains fossils as *Obollela cingulata*, *Orthisina festinata*, *Camerella antiquata*, *Conocephalites teucer*, *Paradoxides thompsoni*, *P. vermontana*	130
5. Bands of bluish mottled dolomite, mixed with patches of gray pure limestone and gray dolomite and bands of gray micaceous flagstone with fucoids	60

A mile or so north of the above section other strata, occur as follows:

6. Light gray more or less dolomitic sandstones and "some of which are fine grained, others are fine conglomerate." These are interstratified with bands of white sandstone	630
7. Bluish thin bedded argillaceous flagstones and slates, containing *Conocephalites arenosus* and fucoids	60
8. Bluish and yellowish mottled dolomite	120
9. Yellowish and yellowish-gray sandy dolomite	600

Still further north, on the Canada line, there are additional strata, though not well exposed, but in general Sir William gives them as follows:

10. Buff and whitish sandy dolomite, holding a great amount of black and gray chert in irregular fragments of various sizes up to a foot in length and six inches wide. There are also masses of white quartz. Thickness (conjectured)	790

Most of the layers are not fossiliferous, and in few are fossils abundant. It may be true that fossils are really more common than they seem to be, for they only occur as casts, and, with the exception of the Algæ, these are rarely visible except when the surface of the stone has weathered so as to leave them in relief, and of course this only happens occasionally. Near Burlington, where the stone is extensively quarried for building purposes, some of the layers exhibit abundant casts of Algæ together with mud cracks, ripple marks and other evidences of shallow water formation. Farther north, at Georgia, and still more to the north at Highgate, various trilobites and Mollusca have been found of the genera Paradoxides, Conocephalites, Camerella, Orthisina, Obolella, &c. (see No. 4 above). The dolomitic portion of the beds constitute what has long been known as the "Winooski marble," to which I wish to call especial attention in the following pages.

The beds of "marble" appear first one or two miles north of Burlington and extend in a somewhat interrupted series north through St. Albans and end between that place and Swanton. Some of the layers are quite distinct from the red sandrock proper, others pass into it by imperceptible gradations. Ordinarily the marble beds are far less siliceous than the main bulk of the sandstone, often containing only one-seventh as much silica as that usually contains, or even less, but they are always much harder than ordinary marble. Analyses of the marble have been made but cannot be of great value when applied to the whole mass because the relative proportion of the substances composing it is extremely variable.

Identical results would scarcely be obtained from analyses of any two specimens taken at places a little distant from each other. Silica is always present, usually about ten per cent, lime carbonate forms from thirty to forty per cent, and magnesia carbonate about the same, while iron and alumina form a smaller portion of the mass.

No fossils had been discovered in this portion of the formation until a few years ago, when on looking over a pile of sawn fragments—refuse from the mill at Swanton—I noticed two or three pieces which contained evident fossils. These were afterwards identified by Mr. Billings as *Salterella pulchella*, described by him from the Straits of Belle Isle, and not hitherto known from Vermont. It is only with difficulty that this fossil can be detected in uncut pieces of marble, but when blocks which contained specimens of it are sawn they are quite noticeable, as they are pure white and imbedded in the red stone, appear as small thimble-shaped, oval, conical or circular bodies, as they are cut in one or another direction. It seems probable that the Salterella occurs throughout the dolomitic beds, for I have found it at their extreme limits near Burlington and Swanton. The fossil is, however, not common anywhere. It occurs in patches sometimes as large as one's hand scattered over the slabs here and there. Other fossils also occur in the marble, but are not so well defined as to be certainly identified.

More than thirty years ago the beauty of the mottled dolomite attracted the attention of marble workers, and a quarry was opened about six miles from Burlington, and some of the blocks of stone taken out were sent to New York and Philadelphia to be sawn into slabs and polished. The results were, I believe, satisfactory in every way except financially. The stone made beautiful slabs for table tops and mantels, but its hardness, while adding to the beauty of the polish which it received, rendered the sawing and finishing so costly that after a short time the attempt to place it in the market was abandoned.

Later quarries were opened near St. Albans, and from these large quantities of stone have been taken, most of it to be manufactured at Swanton into floor tiling, for which it is admirably adapted. This enterprise still continues and has always been prosperous.

The most important attempt yet made to quarry and work up the Winooski marble was begun by a strong company only a short time ago at the old quarries near Burlington.

This company have large capital and have already made such thorough and extensive preparations to prepare the marble for market that if success can be attained in this direction it would seem certain to follow these efforts. Unfortunately, I think, this company have dropped the well-known name "Winooski marble," and substituted that of "Wakefield variegated marble," styling themselves the Wakefield Marble Company. It is no part of my purpose to advertise this company (though every one who knows of what it has accomplished and is trying to accomplish, and who is interested in the development of the resources of the country, must be ready to wish it all success), for this would obviously be wholly out of place here. I think, however, that the possibility of obtaining at a not too great cost an abundant supply of beautiful marble which is unlike any other American marble, and which is fully equal to the finest imported marble for purposes of interior decoration, is a matter of interest to all. This is especially true because of the increasing rarity and costliness of imported marbles, and also because of the increasing demand for colored marbles in fine public buildings. That the Vermont variegated marble is fully equal to that which is imported is, so far as I know, the opinion of all experts who have examined both. In a pamphlet issued by the Wakefield company there are published letters from architects and marble workers which most emphatically declare this to be the fact. The late Hon. Geo. P. Marsh, in a letter written about a year before his death, says: "I have just returned from the national exposition at Florence. * * The brilliant reddish marbles are now very rare; and there was at the exposition none of the reddish class by any means equal to the Wakefield except in small fragments in mosaic work and the Sicilian jaspers."

The Wakefield or Winooski marble has been used in many public buildings in different portions of the country, notably in some of the corridors at the capitol at Albany as wainscoting, and also in the new wing of the Astor library in New York. It should be noticed here that while this marble is unrivaled for inside work it is not well adapted to situations in which it is exposed to the weather, as its colors fade and its beauty is greatly impaired when thus exposed. There seems to be great inequality in this respect in blocks from different layers. At least this is indicated in the appearance of blocks that have been for some years lying about the quarries. Some of these appear to be but very little changed, while others have their surfaces reduced to a nearly uniform yellowish-red. No one need fear any change in the appearance of polished slabs when protected from the inclemency of the weather.

Before attempting any description of the varieties of marble found in the Wakefield and other quarries, it may be well to notice some of the quarries themselves. The most extensive deposits are about the shores of Malletts bay, one of the most picturesque of the many lovely bays which indent the shores of

Lake Champlain. This bay is several miles in length and width and the marble crops out in cliffs from one hundred to two hundred feet high on both sides and forms islands in its midst. The supply is practically unlimited, and so located that huge blocks can be separated from the beds in the quarry, and by the same derrick which lifts them from these beds they may be placed in canal-boats or barges which may convey them by lake, canal and river either to New York or Montreal. In some parts of the cliffs the strata are easily separable, in other parts less easily, but almost anywhere large blocks, which prove sound and perfect throughout, may be obtained.

Perhaps the most remarkable characteristic of this marble is the wonderful variety of shade and general appearance which it presents.

Not only may slabs which are quite unlike each other be obtained from a block as it is sawn parallel with the stratification or transverse to it, any variation in the direction of the saws giving variety in the slabs; but even the opposite surfaces of the same slab may differ greatly. The rock in some of the layers is a more or less complete breccia, white or light-colored fragments being enclosed in a dark red paste. These fragments are of all sizes from those several inches long and wide to those no larger than the head of a pin. In some cases several adjacent bits were, when first held in the paste, one large piece, and subsequently broken, as the fractured edges of each exactly correspond to those of the pieces next it. The brecciated structure is conspicuously perfect in some blocks and quite imperfect in others, and it finally passes into what was evidently a pasty mass of nearly uniform fineness before consolidation took place. Some of the beds appear to have been much more thoroughly worked over, and the materials more completely ground and mixed than others, and the different varieties are in part due to this.

While but few colors are seen in the different layers, nevertheless these are mingled in such varying proportions as to produce unlimited diversity. Shades of red are especially abundant, so that almost every conceivable tint is found; less common are green, chiefly in olive shades, drab and rarely yellow, all mingled more or less abundantly with white. The different specimens may conveniently, though without absolute exactness, be arranged in several series. One of these would embrace those slabs in which the red, which in most cases is the predominating color, is clear and decided. In this series we have many varieties from those in which the red is like that of jasper, or what is known as Indian red, to those in which it is simply a delicate pink like the lining of a shell. Another series gives us the red always of a brownish or chocolate cast, and this is sometimes very dark. This in turn passes through all intermediate shades to almost white. In a third series the red shades are less conspicuous, and with them are mingled greens and greenish-drabs or sometimes lavender shades. It is easy to understand how endless variation may be produced by varying combinations of these different shades with white. This is true both in the blotched and in the shaded layers. Those which show the brecciated structure more or less clearly vary as the fragments are large or small, and whether many large are mingled with many small or the reverse, and whether many large light fragments are mixed with dark small ones, or large dark bits with light small ones, and in the clouded or shaded layers light bands and blotches may predominate in one slab and dark bands in another. It will be obvious that no description of such marbles can convey to those who have not seen them very clear ideas of their appearance, and no attempt to describe all or nearly all of those found will be made. The company have for their own convenience and the purposes of trade, given names to over thirty varieties, all of which may be obtained within a very short distance from their mill on Malletts bay. A few of the leading sorts may properly be mentioned, and perhaps it will not be impossible to give a general idea of some of them. Nearest Burlington there are layers which possibly should be regarded as connecting the marble beds with the ordinary red sandrock. These are chiefly of a dark red slightly clouded and sprinkled with little grains of transparent quartz. This is veined with narrow veins of pure white lime carbonate, which is in pleasing contrast with the red about it. More rarely these veins are of quartz. The veins are usually not at all numerous, and often are only a small fraction of an inch in width. None of the varieties is so hard or so difficult to polish as this, and though handsome it is little used. An allied variety exhibits the white not as distinct veins but as mingled so completely with the red as to give a clouded appearance. Of course in the layers that are brecciated the colors are more or less distinct from each other, and this is also true in some that show no breccia, for in these the colors are in blotches which may not blend to any great extent. One of the most richly shaded of all the varieties is what has been called "Ethan Allen." In this the clear red shades are in wavy bands, dark and light closely intermingled and constantly varying. Across these bands or waves are fine lines of clear white. This variety is finest when in large slabs, and as it receives a very brilliant polish it is very elegant. Some of the chocolate varieties are also very fine, and are admirably suited for wainscoting, mantels or other uses in rooms finished with dark woods. Of the lighter varieties of marble there are many. One of these is called "Florentine." In this the darker shades are mostly wanting, but the surface is covered with irregular blotches, usually not of large size, which are of a delicate pink or flesh color; with these are blotches of light tan and lavender, the whole mingled with white. Running across and through the blotches are lines of dark green. The effect of this combination of colors when a slab is polished is exceedingly beautiful. The "Bonfanti" is somewhat similar. The darker shades of red appear only as lines or small spots. The prevailing tints are pink, flesh color and salmon exquisitely mingled and blended with white and with each other. "Princess" is even more delicate and beautiful with its dainty blotches of lavender and ashes of roses, which give to the whole their peculiarly pleasing tints, while mingled with these are pink, salmon and rose shades and white.

A peculiar variety is "Opal." In this the red tints are largely absent, their place being taken by drabs and white. All of these pretty marbles receive without great difficulty a splendid polish, far more brilliant and durable than that of most of the white or clouded marbles. They are not easily scratched, do not grow dingy and are not stained readily. Ink and many other liquids, so injurious to the more completely calcareous marbles, does not affect these Wakefield varieties in the least. These advantages, aside from their great beauty, amply compensate for the greater cost of the harder marble. While, as has been shown, variety rather than uniformity is the rule among slabs of Wakefield marble, so that out of the hundreds of slabs which may be seen at any time in the store house of the company, no two can be found which are precisely alike (unless they were facing each other in the block, for, of course, when the saw goes through a block the surfaces on each side of it must be alike), yet in most cases it is not very difficult to find a series sufficient for the wainscoting of a large room or the top of a long counter which match closely enough for all practical purposes.

While it has been my aim in what has been said of the different varieties mentioned to convey some idea of what they are, it is wholly impossible to place their beauty before the reader. No agate or jasper is more elegant or attractive. Indeed, in looking over slab after slab of the marble I have often been reminded of the close resemblance to agate which the surface before me presented. The Wakefield marble is, much of it, very similar to agate in brilliancy of polish, delicacy of color and general appearance, though quite unlike it in hardness and costliness. Nor do we ever see slabs of agate five or six feet wide and eight or ten feet long, as are some of the slabs of this marble.

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A BOTANICAL STUDY OF THE MITE GALL FOUND ON THE BLACK WALNUT.[1]

BY LILLIE J. MARTIN.

DEVOTEES to at least four sciences may do original work on *Erineum anomalum.* Since eggs have been found among the hairs on its surface and neither mycelium nor spores occur in it, it can no longer be ranked among the fungi, and the entomologist alone may study the life-history of its inhabitants. The chemist and physicist will certainly have somewhat to do if they set out to find the forces which are at work in the production of the gall. Nor will the botanist be without employment if he trace its anatomy and full development. This paper is a statement of what was seen in a somewhat superficial botanical examination of the gall during the month of July.

These galls usually occur in the walnut on the under side of the main petiole, somewhat below the first set of leaflets, but are occasionally found somewhat higher up. One or even seven or eight galls may be found on the same petiole (Figs. 1, 2, 3). When but one occurs the petiole is shortened and the leaf is rather smaller than the normal leaf; sometimes the petiole is slightly

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[1] Read before the Section of Biology of the American Association for the Advancement of Science in the Philadelphia meeting, 1884.